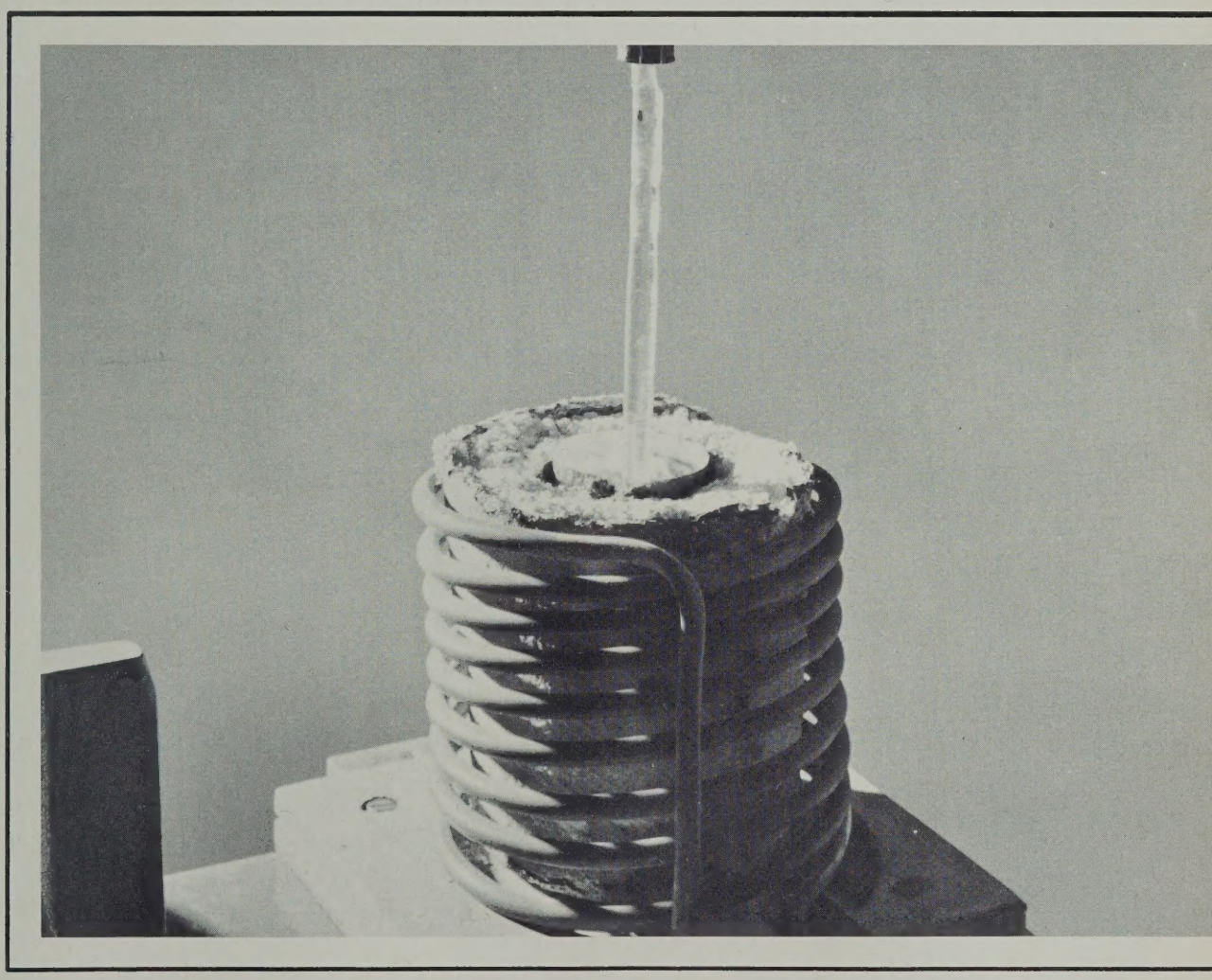
NATIONAL BUREAU OF STANDARDS *February 1967*

Technical News Bulletin



U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

FEBRUARY 1967/VOL. 51, NO. 2/ISSUED MONTHLY

U.S. DEPARTMENT OF COMMERCE
Alexander B. Trowbridge, Acting Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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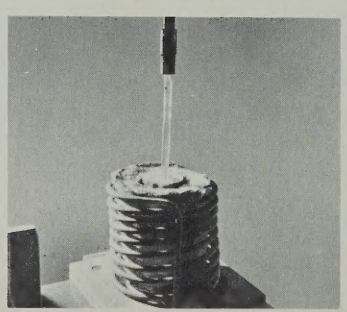

COVER

A lead molybdate crystal that is being grown from molten lead molybdate is almost 8 cm. long. *(See p. 30.)*

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized into three institutes—

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of all three institutes.

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Secretary of Commerce John T. Connor addresses a crowd of 2,500 attending the dedication of the National Bureau of Standards' new laboratory complex at Gaithersburg, Md., November 15. Shown in the photo behind Secretary Connor are: Gordon K. Teal, Director of the NBS Institute for Materials Research; Robert D. Huntoon, Director of the NBS Institute for Basic Standards; Congressman Barber B. Conable of New York; Robert S. Walleigh, Associate Director of the Bureau; NBS Director A. V. Astin; and J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology.

Secretary Connor Dedicates New NBS Laboratories

Guests Tour Facility

"It is no accident of history that the establishment of NBS in 1901 coincided with the beginning of America's transformation into the industrial giant of the 20th century. . . . Today the demands made upon the Bureau and the nature of its program reflect the complexity of our atomic and space-age world." So spoke Secretary of Commerce John T. Connor in dedicating the new Gaithersburg, Md., facilities of the National Bureau of Standards on November 15.

Dedication ceremonies for the $120 million laboratory complex were held in a courtyard between the Bureau's new library and one of the laboratory buildings. In the center of the courtyard is an apple tree descended from the tree under which Sir Isaac Newton was sitting when, according to the story, an apple fell on his head, leading him to conceive the law of universal gravitation.

Surrounding this tree was an audience of 2,500, including distinguished guests from government, industry, and the world scientific community. The ceremony was preceded and followed by performances by the Marine Band. The Reverend Edward G. Latch, Chaplain of the House of Representatives, gave the invocation and the benediction. Dr. A. V. Astin, Director of the National Bureau of Standards, presided, introducing Secretary Connor for the dedicatory address.

Secretary Connor began his remarks with a message from President Johnson. The President noted that throughout its 65 years' existence the Bureau had advanced the frontiers of measurement in pace with the demands of science and industry; he extended his congratulations and best wishes for continuing achievement.

Secretary Connor stated that at age

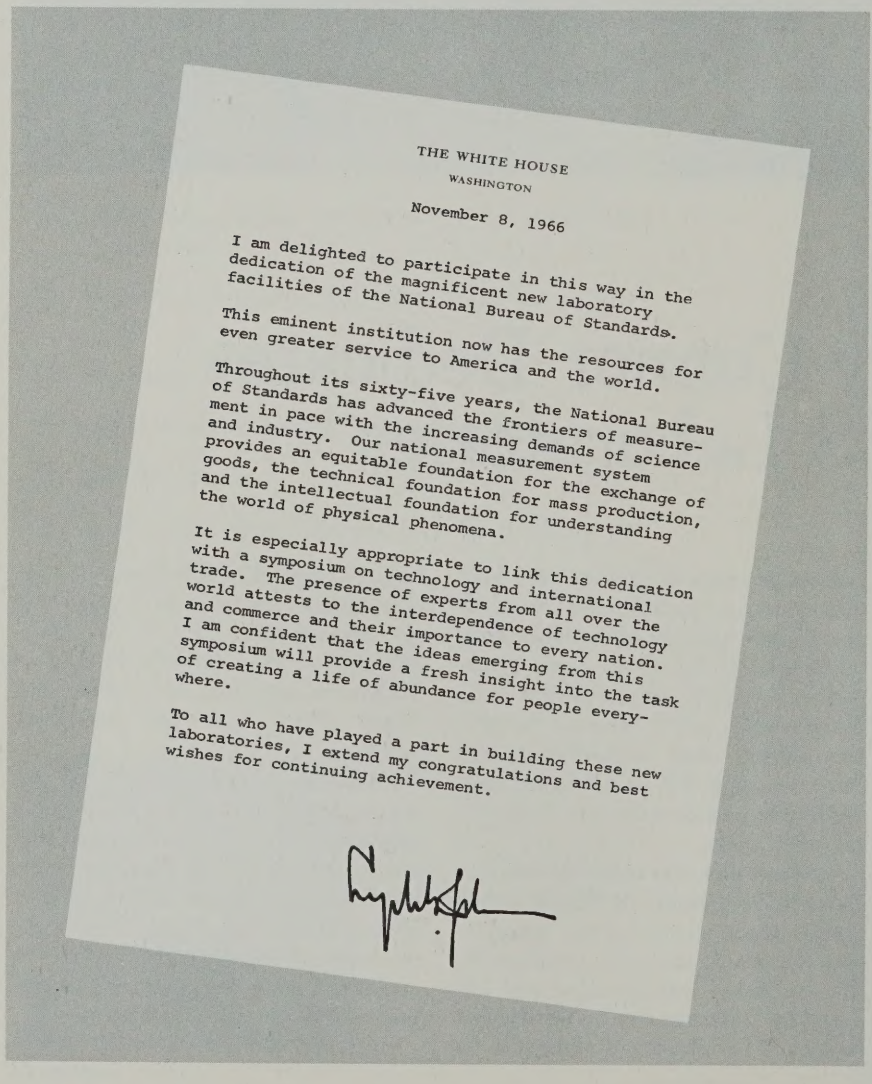
continued

SECRETARY CONNOR *continued*

65 the Bureau had significant accomplishments behind it and a future promising even greater contributions to the Nation. He noted that the new facilities are a symbol of the Bureau's future, but that the germ of future achievement lies in the members of the Bureau's staff.

A plaque commemorating the dedication was unveiled in the nearby Administration Building when the Secretary pressed a button at the podium. This button activated a radio receiver tuned to one of the standard frequencies (5 MHz) broadcast by NBS station WWV at Greenbelt, Md. Reception of the standard frequency triggered circuitry which opened curtains to unveil both the dedication plaque and a replica of it which had been placed above the speaker's platform.

Following the dedication ceremonies, the visitors were invited to tour many of the new laboratories. Included in the tours were a 100-foot linear accelerator which produces one of the world's most intense electron beams; a recently completed high-flux research reactor; and a 12-million-pound capacity hydraulic testing machine, believed to be the world's largest. Also on display were a museum of measurement science and the vault in which the national measurement standards are kept. The NBS Museum contains historical instruments, equipment, standards, and materials that have been of significance in the activities of the Bureau during its 65-year history.



THE WHITE HOUSE
WASHINGTON

November 8, 1966

I am delighted to participate in this way in the dedication of the magnificent new laboratory facilities of the National Bureau of Standards.

This eminent institution now has the resources for even greater service to America and the world.

Throughout its sixty-five years, the National Bureau of Standards has advanced the frontiers of measurement in pace with the increasing demands of science and industry. Our national measurement system provides an equitable foundation for the exchange of goods, the technical foundation for mass production, and the intellectual foundation for understanding the world of physical phenomena.

It is especially appropriate to link this dedication with a symposium on technology and international trade. The presence of experts from all over the world attests to the interdependence of technology and commerce and their importance to every nation. I am confident that the ideas emerging from this symposium will provide a fresh insight into the task of creating a life of abundance for people everywhere.

To all who have played a part in building these new laboratories, I extend my congratulations and best wishes for continuing achievement.

Planning for the new Gaithersburg laboratories began in 1955 when the administration proposed that new NBS facilities be constructed outside of Washington. By that time a new location and new facilities for the Bureau were greatly needed. Not only were some of the buildings more than 50 years old, but room for expansion was decreasing while electrical, mechanical and atmospheric interference from the surrounding city increasingly disturbed the Bureau's work.

After inspecting many sites for suitability for its special requirements, the Bureau acquired 565 acres in the rolling farmland of Montgomery County, Md., within 20 miles of the original grounds. Plans for the buildings at the new site were carefully tailored to the needs of the laboratories. Construction began in June 1961 and the first laboratory moved into its new quarters early in 1964. Planning for the dedication of the facility began when the majority of the staff had relocated at the new site.

Construction of the new laboratories was programed in phases; the administration complex, the seven general purpose laboratory buildings, the engineering mechanics building, the radiation physics complex, the nuclear reactor, the refrigerating and heating plant, and the supply facilities were completed and largely occupied by the time of the dedication. Still under construction are the special purpose laboratories (sound, hazards, industrial, and concreting materials), while others are still in the planning stage.

In connection with the dedication, the Secretary of Commerce sponsored a Symposium on Technology and World Trade, which was held at the Bureau during the 2 days following the dedication (see opposite page).

Symposium on Technology and World Trade

Vice President Hubert H. Humphrey speaks at the banquet for the Symposium on "Technology and World Trade" in the Diplomatic Functions Room of the Department of State. Mr. Humphrey's address was entitled "Technology and Human Betterment." Seated (left) is Professor Marshall McLuhan of the University of Toronto.

A Symposium on Technology and World Trade was held November 16 and 17, 1966, at the Gaithersburg (Md.) laboratories of the National Bureau of Standards under the sponsorship of Secretary of Commerce John T. Connor. The Symposium was part of the dedication program for the Bureau (see p. 23). Over 500 distinguished experts from 25 nations took part in the Symposium at the Secretary's invitation. They represented such varied disciplines as cultral anthropology, sociology, psychology, communication, economics, finance, engineering, industrial management, and the physical sciences.

The purpose of the Symposium was threefold: first, to look at the growing impact of technology upon trade and investment; secondly, to outline a world environment that will encourage more widespread use of technology; and finally, to seek new ways to promote economic development through technology and trade.

The theme of the first day of the Symposium was "The Technological Component of World Trade and Investment." The second day was concerned with "Creating the Environment for Fruitful Interactions of Technology, Trade, and Economic Growth."

Secretary Connor opened the Symposium, telling the attendees he was confident that the meeting would repay their efforts with a clearer view of their common problems in the global exchange of goods, services, commodities, techniques, knowledge, attitudes, and ideas. He pointed out that the Symposium occurred at an especially appropriate time, coinciding with the dedication of the new NBS laboratories and with the increased emphasis placed by the Bureau on cooperation with business and industry. The Secretary noted four areas that NBS is emphasizing: international standardization, the development of performance criteria for technological goods and services, methods of measuring the performance of technological systems, and the dissemination of scientific data and technical information. "These activities," he said, "all have great relevancy to increasing international trade."

Dr. A. V. Astin, the Director of NBS, in his role as Chairman of the session on the Impact of Standards on World Trade, introduced the subject by reference to the significant mention in the United States Constitution of the authority given Congress to "coin money, regulate the value thereof, and fix the standard for weights and measures." Thus the relationship between standards and the ability to trade have been linked in U.S. governmental practice since the earliest days. Francis McCune of the General Electric Company pointed out the usefulness of standards in giving coherent, definitive summaries of technological developments and products or services offered for intenational trade. With a rising component of technology in products that are being traded, he underlined the need for expanded standard-making effort.

A. H. A. Wynn of the British Ministry of Technology stressed the need for increased effort and leadership, especially by the United States, to reduce the list of fields in which existing standards or the lack of standards are still hinderances to international trade. While in the past the principal effort toward international standardization has been made by the countries that export large fractions of their gross national product, greater U.S. participation should be likely, now that it too is finding a greater ininterest in and dependence on trade with other countries. Mr. Wynn applauded the formation of the United States of America Standards Institute as a significant move that will benefit all trading nations of the world.

Among the comments made by the four formal discussants of this session, Mr. Fayvel Haddass of Israel underlined the importance of making available to the underdeveloped nations sets of product standards that will give these nations clear statements of quality or performance requirements so that their exports may also compete fairly for world markets. Since underdeveloped countries will have difficulty in developing their own stand-

continued

ards, the developed countries should take on the burden of providing these as a form of enlightened self-interest. Such steps will promote the buying power of the population in the large potential markets of the underdeveloped countries.

Francis LaQue of the International Nickel Company made an interesting translation of Dr. Marshall McLuhan's comments, made during the morning session, in the context of the standards world. He proposed that the more traditional standards which specify size, configuration and materials of construction are in Dr. McLuhan's terms to be considered "hot" or nonparticipative. The newer form of standards, those based on performance criteria, are "cool" and participative because they offer producers the opportunity to meet the desired function by a variety of methods limited only by imagination, cost, and available technology.

Samuel Watson of the Radio Corporation of America spoke of the value of standards as an aid to international communication and understanding. He would like to see an expansion of the resources expended toward standardization because standardization is one of the surest methods of overcoming the greatest obstacle in international transactions—the language barrier.

C. H. Sharptson of the International Standards Organization (ISO) readily admitted that there is no simple solution to the problem of choosing the best organizational means for arriving at standards. He did make the recommendation, however, that the technological content of standards be ironed out internationally at the earliest possible date through the facilities of international nongovernmental bodies, such as the ISO or International Electrochemical Commission. Thus he foresees new opportunities to steer national, multinational, or even regional groups toward world standards. He said this should be done by encouraging consensus to develop as a result of the specific technology involved or by trying to "discretely prevent" potential collisions that result from the pressures of independent national actions.

International competition and cooperation in technology were discussed in the luncheon address on November 16 by Dr. Pierre Uri, Counselor for Studies, Atlantic Institute, Paris, France. He treated competition and cooperation as opposite sides of the same coin, arguing against a case where two countries might cooperate with one another in order to compete against a third. He found encouragement, however, in the existence of some 300 national and regional organizations dedicated to various forms of international cooperation and competition.

Vice President Hubert H. Humphrey backed multinational proposals such as that providing for a European Technological Community, and more rapid and complete economic integration of developing Latin American, Asian, and African nations; he also favored an international patent system; possible establishment by private corporations of "joint training institutes in talent-short parts of the world"; increased receptivity by U.S. Government agencies "to proposals from other governments, from international organizations, from private companies or groups of companies, from any source in fact which wants to put technology to wider and better international use." The Vice President warned that in meeting world economic and social challenges the United States tends to underemphasize training institutions and facilities devoted to such fields as educ*ation*, transport*ation*, nutri*tion*, communic*ation*, and irrig*ation* which meet direct human needs—as compared to phys*ics*, opt*ics*, or nucleon*ics* which have less widespread impact on the world's population.

At the luncheon on November 17 Dr. Ibrahim Helmi Abdel-Rahman, Commissioner for Industrial Development, United Nations, called for closing the gap in developing countries. In his native village, he noted, farmers have transistors, if not farm machinery—illustrating the prevailing consumer psychology and lack of production technology. He advocated revival of a "concept of shared responsibility" as the path along which developed and developing nations can travel together toward peace and economic development. Comparing technology transfer between nations to the transfusion of blood in living bodies, Dr. Rahman said that a technology "world blood bank," such as Prof. V. K. R. V. Rao had proposed in the morning session, would be too much like blood in a test tube. "You can have institutes studying blood, and you can have institutes studying technology," he said. "You have to make the connection for taking technology into the mainstream."

The final session of the Symposium emphasized the role of the international corporations.

Dr. Aurelio Peccei, chief executive of Olivetti in Ivrea, Italy, said new approaches are needed to spur international exchange of basic and applied technology. As a contribution toward this end, he described an Italian governmental proposal for an agreement starting among NATO countries and possibly joined later by other countries.

The roles of skilled management and of individual invention and entrepreneurship were the focus of much discussion at the Symposium. Speakers pointed out that neither scientific discovery nor heavy research and development expenditures automatically bring about technological advance. As Bell & Howell President Peter G. Peterson put it, fulfillment of the promises of science and innovation requires "an impedance match between the laboratory and the market place."

Proceedings of the Symposium are being published by the National Bureau of Standards and are expected to be available in the spring of 1967 from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

SYMPOSIUM ON TECHNOLOGY AND WORLD TRADE

Program

Wednesday, Nov. 16, 1966

9:30 Introduction:

Dr. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology

Opening Statement:

TECHNOLOGY AND MANAGEMENT AS INSTRUMENTS FOR WORLD PROGRESS

Mr. John T. Connor, Secretary of Commerce

Theme for Wednesday

THE TECHNOLOGICAL COMPONENT OF WORLD TRADE AND INVESTMENT

10:00 TECHNOLOGY: ITS INFLUENCE ON THE CHARACTER OF WORLD TRADE AND INVESTMENT

Chairman:

Dr. Frederick Seitz, President, National Academy of Sciences and National Research Council

Speakers:

Professor Marshall McLuhan, Director
Center for Culture & Technology
University of Toronto
Toronto, Canada

Professor Richard N. Cooper
Department of Economics
Yale University
New Haven, Conn.

Discussants:

Dr. H. B. G. Casimir
Director of Research Laboratories
N. V. Philips Industries
Eindhoven, the Netherlands

Mr. John E. Reynolds
Board of Governors
Federal Reserve System
Washington, D.C.

12:30 Luncheon

Introduction:

Mr. Herman Pollack, Director of International Scientific and Technological Affairs, Department of State

Address

INTERNATIONAL COMPETITION AND COOPERATION IN TECHNOLOGY

Speaker:

Dr. Pierre Uri
Counselor for Studies
Atlantic Institute
Paris, France

2:30 THE IMPACT OF INTERNATIONAL MEASUREMENT CONVENTIONS, NORMS AND STANDARDS ON WORLD TRADE

Chairman:

Dr. A. V. Astin, Director, National Bureau of Standards

Speakers:

Mr. Francis McCune
Vice President
General Electric Company
New York, N.Y.

Mr. A. H. A. Wynn
Head, Enginering Standards Division
Ministry of Technology
London, U.K.

Discussants:

Mr. Fayvel Haddass
Director
Standards Institution of Israel
Tel Aviv, Israel

Mr. Samuel H. Watson
Manager, Corporate Standardizing
Radio Corporation of America
Camden, N.J.

Mr. Francis L. LaQue
Vice President
International Nickel Co., Inc.
New York, N.Y.

Mr. C. H. Sharpston
Secretary-General
Int'l Organization for Standardization
Geneva, Switzerland

7:15 Banquet

Chairman:

Mr. John T. Connor, Secretary of Commerce

Speaker:

Hon. Hubert H. Humphrey, Vice President of the United States

Address:

TECHNOLOGY AND HUMAN BETTERMENT

Thursday, Nov. 17, 1966

Theme for Thursday

CREATING THE ENVIRONMENT FOR FRUITFUL INTERACTIONS OF TECHNOLOGY, TRADE AND ECONOMIC GROWTH

9:30 THE IMPACT OF THE POLICIES OF GOVERNMENT ON THE CREATION AND USE OF TECHNOLOGY FOR ECONOMIC GROWTH

Co-Chairmen:

Dr. Donald F. Hornig
Special Assistant to the President for Science and Technology

Dr. J. Herbert Hollomon
Assistant Secretary of Commerce for Science and Technology

Speakers:

Dr. Robert Major
Director of Science and Technology
Oslo, Norway

Mr. Peter G. Peterson, President
Bell & Howell Company
Chicago, Ill.

Discussants:

Professor James Brian Quinn
Dartmouth College
Hanover, N.H.

Professor V. K. R. V. Rao
Member, Planning Commission
Government of India
New Delhi, India

12:30 Luncheon

Introduction:

Mr. Alexander B. Trowbridge, Assistant Secretary of Commerce for Domestic and International Business

Address:

TECHNOLOGY AND THE DEVELOPING COUNTRIES

Speaker:

Dr. Ibrahim Helmi Abdel-Rahman, Commissioner for Industrial Development, United Nations, New York, N.Y.

2:30 THE TRANSFER OF TECHNOLOGY THROUGH ENTERPRISE-TO-ENTERPRISE ARRANGEMENTS

Chairman:

Professor Hollis B. Chenery
Department of Economics
Harvard University
Cambridge, Mass.

Speakers:

Mr. Elmer S. Groo
Vice President
IBM World Trade Corporation
New York, N.Y.

Dr. Aurelio Peccei
Chief Executive
Ing. C. Olivetti & C., S.p.A
Ivrea, Italy

Discussants:

Dr. John H. Dessauer
Vice President
Xerox Corporation
Rochester, N.Y.

Dr. L. R. W. Soutendijk
Brown Bros. Harriman & Company
New York, N.Y.

Dr. Antonie Knoppers, President
Merck, Sharp & Dohme International
New York, N.Y.

4:45 CLOSING REMARKS

Mr. John T. Connor, Secretary of Commerce

Dr. Ibrahim Helmi Abdel-Rahman speaking on "Technology and the Developing Countries" at the Symposium luncheon on Thursday, November 17. Secretary of Commerce John T. Connor, who sponsored the Symposium, is seated (second from left) at the table in front of Dr. Rahman.

Fire and Smoke Resistance of Doors Evaluated

Many houses and apartment buildings are so constructed that their partition walls can contain a fire for several hours. However, the partition walls, especially in older buildings, may be equipped with wood panel doors that are relatively weak fire barriers and will burn through in seveal minutes. Modifications in existing doors, to improve their effectiveness as fire and smoke barriers, may increase the time available for evacuation of buildings during fires.

In an effort to solve this problem, the NBS Institute for Applied Technology has recently completed a study to determine the effectiveness of door modifications in increasing their fire-resistance value. In addition, this study [1] by H. Shoub and D. Gross considered the feasibility of controlling the smoke flow past the doors by modifying the edges and changing the neutral pressure zone of adjoining rooms.

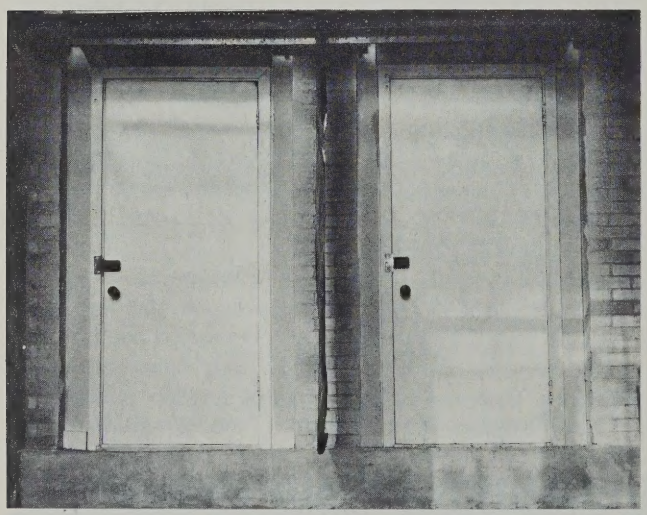
In this investigation eight pairs of doors were subjected to fire tests in a panel test furnace. The doors were obtained from razed apartment buildings and then modified. The modifications included filling the door panel spaces, then covering the doors with hardboard, asbestos-cement board, or galvanized-sheet steel. In addition, some of the doors were painted with flat interior paint, interior enamel paint, glass fiber-reinforced paint, or commercial fire-resistant paint. Lumber frames, covered with gypsum board, were constructed for the doors to simulate partition walls.

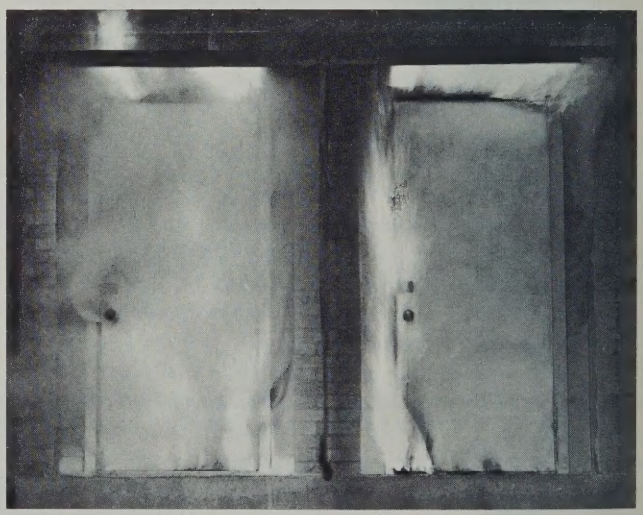
The study indicated that conventional wood panel door and frame assemblies cannot be expected to act as effective fire barriers for more than approximately 5 minutes. Nor did the application of conventional paints and a conventional commercial fire-retardant paint provide any significantly greater protection. However, increased fire protection was obtained in a panel door that had been coated with a fire-retardant paint reinforced with glass fiber. This door acted as an effective barrier for 16 minutes. Also, the door assemblies with the panel spaces filled out and with noncombustible facings of asbestos-cement board or sheet-steel added, acted as effective fire barriers for periods ranging from 17 to 41½ minutes.

None of the doors that were modified with added protective materials achieved fire protection duration times comparable to those attained by two rated metal fire doors included in the study for comparison.

Smoke Protection

As more fatalities are attributed to asphyxiation than to direct burns, the resistance of a door to smoke passage is an important safety consideration. In a typical situation, the pressure in the fire area is greater at high levels and less at low levels, than the pressure in an adjoining area. Thus, air flows into the fire area through low-level openings, and the smoke and gases flow out of the fire area through high-level openings. The horizontal plane at which the pressures are equal is termed the neutral





Door and frame assemblies before (2 left) and during (2 right) an NBS fire test to determine their fire and smoke resistance. This investigation revealed the effectiveness of modifications to doors to increase fire and smoke resistance.

zone. It was found that by changing the location of the neutral zone in a room adjoining a fire, the density of the smoke could be reduced. The smoke density was reduced to a very low value when the neutral zone was shifted to the top of the door or above using vents of the proper size and location.

Several other means for reducing the flow of smoke past the doors were also examined. The use of metal weather strips appeared to be only slightly effective. The application of a reinforced fire-retardant paint to the door edges did not prove effective in the study, even though a thick coating would sometimes expand and provide a seal between the door and its frame.

Preliminary small-scale tests of a commercial intumescent strip, for application to door edges or jambs, indicated that such strips may be of more value than paint coatings. Using the strip, which is available in Europe for building and shipboard installations, a significant decrease was obtained in the quantity of smoke passing around the door edges as compared to an unmodified assembly. However, these strips do not provide full protection because, even in the presence of a nearby fire, cool smoke of toxic quantity may spread through adjoining areas before the strip reaches the temperature necessary to seal.

None of the modifications offered an effective means of preventing the transmission of smoke around the edges of the doors, even for those doors rated as good fire barriers.

[1] For further details, see **Doors as Barriers to Fire and Smoke**, by H. Shoub and D. Gross, NBS Bldg. Sci. Series No. 3 (March 1966). For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. (15 cents).

Trace Characterization Symposium Held at NBS

The NBS Institute for Materials Research hosted over 550 scientists at its Symposium on Trace Characterization—Chemical and Physical, October 3 to 7, 1966. This symposium, held at the Bureau's new site near Gaithersburg, Md., was the first of a planned series of annual symposia on materials science.

The first symposium summarized the present capabilities and future potentials of the more useful tools for trace characterization of materials. Emphasis was placed on exchanging knowledge and establishing effective intercommuncation among the various disciplines on which a complete and meaningful trace characterization depends.

The symposium arrangements were handled by a committee chaired by W. Wayne Meinke, Chief, NBS Analytical Chemistry Division, who was assisted by Roger G. Bates, Chief, NBS Electrochemical Analysis Section. The technical program chairman was Bourdon F. Scribner, Chief, NBS Spectrochemical Analysis Section.

In the opening address, N. B. Hannay, of the Bell Telephone Laboratories, described the effects of trace chemical constituents, either added deliberately or present as impurities, and of microscopic defects on the properties of materials. Because of these effects, a complete description of any material should include the kind, amount, and distribution of trace chemical or physical constituents.

The major part of the Symposium was devoted to a detailed consideration of 10 important methods of trace characterization. For each of these methods an invited speaker summarized the present state of the art including limitations and possible means of improvement, and a rapporteur led a discussion session for contributed papers. Although only a few of the contributed papers were presented orally, all papers were preprinted for use of the participants. The rapporteur summarized the salient points of these papers and showed their relationship to one another.

This system proved effective, as it was possible to include 90 contributed papers in the program without simultaneous sessions, and to have ample time for discussion. This enabled each registrant to take part in all sessions. It also permitted the discussion to include critical comparisons of different methods of trace characterization, as well as details of individual techniques.

Topics of general interest, such as how limits of detection should be defined, were also considered. In the past, there has been little agreement on such questions. For example, various papers in one session contained detection limits measured in terms of the net signal, the ratio of signal to background, and the ratio of signal to noise. This underlined the need for agreement on definitions of such terms.

The invited lectures and summaries of the contributed papers and the discussions will be published by the U.S. Government Printing Office as NBS Monograph 100. This publication is expected to be available by April 1967.

S. F. Holley observes the growth of a lead molybdate crystal (at center), which has already reached about 8 cm. in length. Molten lead molybdate is contained in the platinum crucible that is being heated by radiofrequency induction below the crystal.

Dielectric Properties Measured for Possible Laser Materials

The dielectric properties of two materials which may have potential value for devices, such as lasers, have been determined recently at the NBS Institute for Materials Research. In a study supported in part by the Atomic Energy Commission, single crystals of calcium molybdate and lead molybdate were prepared, and values of the heretofore unreported anisotropic dielectric constants were measured.[1] Such data are required by scientists and engineers who are studying new devices for applications in the communications and electronics fields.

W. S. Brower of the NBS crystal chemistry laboratory and P. H. Fang of the National Aeronautics and Space Administration collaborated in this study of the two materials, which have the same crystal structure as calcium tungstate (scheelite), a compound used extensively as a host crystal for solid lasers. These materials were produced and characterized at NBS as part of a program to furnish physical property data on materials to science and industry.

The single crystals of lead molybdate and calcium molybdate were produced by the Czochralski technique. In this method of crystal growth, a seed crystal was dipped into a crucible containing the molten material and slowly withdrawn. As the seed was pulled out of the liquid, the compound solidified on the seed crystal as a single crystal. Single crystals were grown 5 to 10 cm. long and they had the orientation of the seed crystal.

After the single crystals of lead molybdate and calcium molybdate were obtained, they were cut into disks with diameters of 8 to 10 mm. and thicknesses of 0.5 mm. The surfaces of the disks were polished and a silver film was deposited on these surfaces by evaporation. The orientation of the faces of the disks was predetermined by the Laue-back reflection x-ray method and the disks were cut with the a- and c-crystallographic directions perpendicular to the faces. These crystallographic directions were the only two necessary for determining the anisotropic dielectric constants of the tetragonal structure.

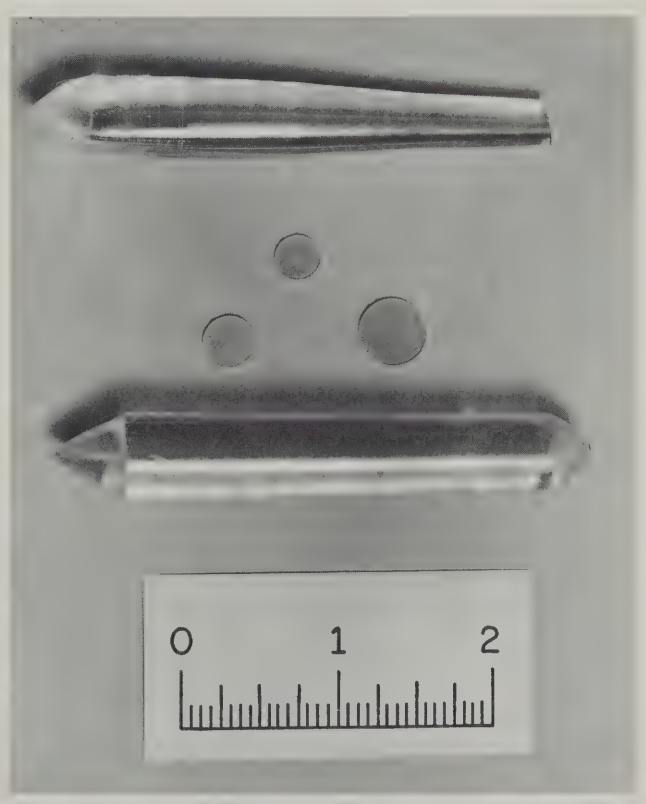
The dielectric constants were measured by a capacitance substitution method. In this technique samples were placed between the plates of a parallel plate capacitor and the capacitance of the crystals was determined. The dielectric constants were then calculated from the ratio of the capacitance of the sample to the capacitance of air. All measurements were made in air at 24.5° C. (room temperature) and at a frequency of 1.59 kHz.

For the measurements made parallel to the a-axis, the relative dielectric constant was found to be 34.0 for the lead molybdate and 24.0 for the calcium molybdate. For the measurements parallel to the c-axis, the dielectric constant was 40.6 for the lead molybdate and 20.0 for the calcium molybdate. The dielectric loss for both orientations of the lead molybdate was of the order of 10^{-2} and for the calcium molybdate, 10^{-3}.

Examination of the results shows that the dielectric constant is greater in the c-direction for the lead molybdate, but greater in the a-direction for the calcium molybdate. This inversion of the anisotropy leads to the hypothesis that the dielectric constants for these materials depend on the polarizability of the ions in the lattice. That is, because similar types of atoms in these classes of compounds occupy the same relative positions in the lattice structure and because the lattice constants are not very different, the anisotropy of the dielectric constants would be expected to be similar in the two materials. As this is not the case, the values obtained for dielectric constants are assumed to result from the polarizability of the different atoms in the structure when the crystal is placed in an electric field.

[1] For further technical details, see Dielectric constants of $PbMoO_4$ and $CaMoO_4$, by W. S. Brower and P. H. Fang, Phys. Rev. Section 2 (Sept. 1966).

Samples of the "as grown" crystals of calcium molybdate (at top) and lead molybdate (at bottom) are shown. From such crystals, thin disks (center) are cut for the dielectric constants measurements.



A class in flow measurement at the GWU Center for Measurement Science. The instructors, standing at the blackboard, are L. H. Glassman, Associate Professor of Engineering and Applied Science, and (right, behind speaker's desk) H. H. Allion of the Fluid Meters Section of the NBS Institute for Basic Standards. (Photo courtesy the Goddard Space Flight Center, NASA.)

Measurement Science at George Washington University

A broad program of education in measurement, from a 2-year technologist's course to the doctorate, plus intensive short courses answering immediate special needs of industry, is currently being offered by the Center for Measrement Science of the School of Engineering and Applied Science of the George Washington University in the District of Columbia.[1] The Center also does research and consulting on measurement problems.

Founded 6 years ago,[2] the Center for Measurement Science (CMS) is a cooperative activity of the university, industry, and government. Among government agencies, NBS has played an active role since the start; it was an original sponsor and supplies a good part of the Center's faculty.[3] The Goddard Space Flight Center and the U.S. Army Materiel Command have also been prominent in CMS programs.

Four-Stage Curriculum

There are four main lines of study integrated into a single program, so that the student can travel as far as his interests and capacities permit. A high school graduate who satisfies the requirements for admission may study for 2 years, receiving an Engineering Technologist Certificate, or for 4 years, receiving the Bachelor of Science (Measurement Science) degree; after which he may go on to the degrees of Master of Science and Doctor of Science.

About half the courses in the 2-year program for the Engineering Technologist Certificate are in mathematics, physical science, and general engineering, the other half consisting of courses more directly concerned with measurement. The former include finite mathematics and statistics, calculus, general physics, analytical mechanics, introduction to theoretical physics, engineering design, and basic engineering laboratory. The measurement courses deal with techniques of engineering experimentation, fundamentals of measurement science, transducers and instrumentation, and statistics in metrology.

There are 10 areas in which the GWU Engineering School awards the B.S. degree, one of which is Measurement Science. The curriculum for this is designed to prepare the student for such activities as testing missiles and space vehicles, measuring characteristics and properties of materials, evaluating standards of measurement in various fields of science and medicine, design and construction of measuring instruments, design and execution of experiments and tests of various kinds, and control of quality of manufactured products.

Required courses for the "B.S. (Measurement Science)" degree include engineering electronics, introductory and advanced transducers and instrumentation, pressure measurements, precise electrical measurements, precise mechanical measurements, and precise heat measurements.

Graduate courses presently available include electronic measurements in medicine, instrumentation in medical electronics, advanced general metrology, probability and statistics of metrology, precise microwave measurements, precise optical measurements, and precise electrical standards.

Special Courses

Special short courses, seminars, and conferences are arranged from time to time to report on reseach in progress, discuss new developments and advances in science and technology, and provide a mechanism for the exchange of information among the individuals, private companies, and government agencies associated with the Center.

Recent courses have been given on Maintainability—Engineering and Management, Standards and Calibration Laboratories, Dynamic Instrumentation, Vacuum Technology, and precise Microwave Measurements. Usually lasting 1 week, the short courses attract large attendance from industries throughout the Nation as well as government agencies.

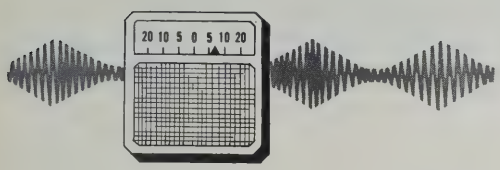
Students

Approximately 50 students, mostly at the master and doctor level, are enrolled in measurement science curricula, including students assigned from the Air Force and by the governments of Canada, Ceylon, Ireland, and Egypt. Research at NBS is an important part of the graduate studies of these students, and provides a unique experience in precise measurement problems and their solution.

[1] Further information can be obtained by writing to the Center for Measurement Science, the George Washington University, Washington, D.C. 20006.

[2] See, NBS to cooperate in new Institute of Measurement Science, NBS Tech. News Bull. 44, No. 12, 212 (Dec. 1960).

[3] NBS staff members serving on the CMS faculty have included: H. H. Allion, D. W. Baker, J. M. Cameron, T. J. Filban, G. T. Furukawa, L. A. Guildner, F. K. Harris, D. P. Johnson, H. H. Ku, A. G. McNish, P. E. Pontius, J. C. Richmond, S. Ruthberg, R. Stair, W. J. Youden (now a full-time professor at the GWU School of Engineering and Applied Science), and T. R. Young.



STANDARDS AND CALIBRATION

STANDARD FREQUENCY AND TIME BROADCASTS

WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz

WWVH—2.5, 5.0, 10.0, and 15.0 MHz

WWVB—60 kHz

Radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms. as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. Adjustments are made at 0000 UT (7:00 p.m., e.s.t.) on the first day of a month. There will be no adjustment made on March 1, 1967. The pulses occur at intervals that are longer than one second by 300 parts in 10^{10} due to an offset in carrier frequency coordinated by the Bureau International de l'Heure (BIH), Paris, France.

Radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses derived from the NBS Time Standard (NBS—III) with no offset. Step adjustments of 200 ms. are made at 0000 UT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms. of UT2. There will be an adjustment made on March 1, 1967. The seconds pulses emitted from WWVB will be retarded 200 ms.

PEAK PULSE VOLTAGE STANDARD IMPROVED

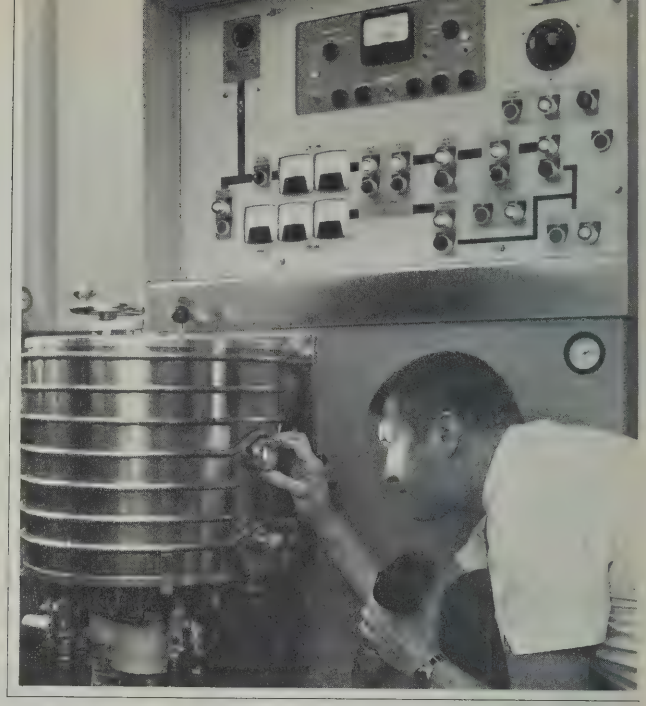
The risetime characteristics of the NBS reference standard pulse voltmeter have recently been improved by a factor of at least 30. The risetime of the standard was formerly of the order of 10 nanoseconds. As a result of the improvement, it has been reduced to 0.3 nanosecond. A nanosecond is 1 billionth (10^{-9}) of a second.

Measurement of the peak voltage of fast-rise, short duration (1 nanosecond or less) pulses is important in many segments of the electronics industry. Such pulses are widely used in the high-speed electronic computer industry and in a great many scientific and engineering applications. The present improvement thus makes it possible for NBS to calibrate instruments and pulsers with subnanosecond capabilities.

The NBS standard is based on the slideback principle and employs a back-biased diode.[1] The reduction in risetime was achieved mainly by the use of a new high-speed diode and a coaxial mounting arrangement for the bias batteries. Mounting the batteries (miniature mercury cells) in this type of structure greatly reduced impedance mismatches which were present in the earlier standard.

Further improvement in the standard is planned. The present state of the art in fast pulse generation is of the order of 0.03 nanosecond (30 picoseconds).

[1] Described in NBS Tech. News Bull. 50, 162 (Sept. 1966). For technical details, see A. R. Ondrejka and P. A. Hudson, J. Res. NBS 70C (Engr. & Instr.) No. 1, 13–18 (Jan.–Mar. 1966).



High-temperature, high-vacuum furnace at NBS used to prepare the samples of platinum-metal alloys. R. M. Waterstrat is shown adjusting the furnace temperature.

Alloy Structure Studies
Lead to New Superconductor

A better understanding of the properties of alloys containing platinum-group metals is expected to result from studies being conducted jointly at the NBS Institute for Materials Research and the U.S. Navy Marine Engineering Laboratory. These studies have been conducted by R. M. Waterstrat, a research associate of the American Dental Association at NBS, and Dr. E. C. van Reuth, a senior research scientist at the Navy Marine Engineering Laboratory. As a result of this investigation, a chromium-osmium alloy was discovered to be a superconductor.

A series of different alloys has been prepared at NBS usually to the chemical formula A_3B, where A is a specific metallic element and B is an element from the platinum-metal family. The alloys all have the typical A15-type crystal structure which resembles a cube with certain atoms located at each corner and at the center of the cube while other atoms are located in pairs on each cube face. The affinity of an atom for one or the other of these locations is a property which is referred to as the degree of long-range order.

In order to determine the degree of long-range order in these alloys, measurements were carried out jointly by Mr. Waterstrat and Dr. van Reuth on x-ray diffraction patterns.[1] The relative line intensities in these patterns were compared by computer with intensities calculated for A15-type structures with various degrees of long-range order. An arbitrary scale of order used by scientists for comparison assigns a value of zero to a completely disordered alloy and 1.0 to an alloy which is perfectly ordered.

The 18 alloys studied were found to posses degrees of long-range order ranging from 0.66 for a chromium-osmium alloy to 1.00 for a titanium-platinum alloy. In this study the A metallic element was chosen to be either chromium, vanadium, titanium, niobium, or molybdenum while the B element was a platinum-group metal such as osmium, iridium, platinum, rhodium, or gold. A significant difference in atomic number, which determines the x-ray scattering factor, exists between these two groups of elements and thus provides a sensitive x-ray measurement of the degree of long-range order.

Some of the alloys studied have been reported to be superconductors at very low temperatures (less than 1–5 °K). As a corollary to their work, therefore, Mr. Waterstrat and Dr. van Reuth felt that measurements to detect superconductivity would be desirable on each of the alloys prepared at NBS. The alloys were tested for superconducting transitions by Dr. R. D. Blaugher at the Westinghouse Defense and Space Center. A previously unreported transition to a superconducting state was found to occur in the chromium-osmium alloy at a temperature of 4.03 °K. Experiments are now in progress to relate the degree of long-range order in this alloy to the existence of the superconducting state.

The partial disordering of the chromium-osmium alloy could be attributed to a change of the atomic proportions in the alloy, which was necessary for obtaining the A15 type structure. Ideally this structure would contain 75 atomic percent of the given metallic element to 25 atomic percent of platinum-group metal atoms if each atom location in the structure were occupied exclusively by one element. An A15 type structure for the chromium-osmium alloy, however, could be obtained only by changing this ideal stoichiometry to 72 atomic percent chromium and 28 atomic percent osmium. The slight change in the atomic proportions of the alloy would naturally cause the long-range order to decrease in the lattice structure since the numbers of constituent atoms

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NSRDS NEWS

This column regularly reports significant developments in the program of the National Standard Reference Data System. The NSRDS was established in 1963 by the President's Office of Science and Technology to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the National Bureau of Standards through the NBS Office of Standard Reference Data, located in the Administration Building at the NBS Gaithersburg Laboratories.

Cryogenic Data Center

The Cryogenic Data Center operates within the Cryogenics Division of the Institute for Materials Research in Boulder, Colo. It began its activities in 1958 under an Air Force contract to make an extensive literature search and survey on the properties of materials used at low temperatures. Currently the Center is associated with the NBS Office of Standards Reference Data and its compilation activities are supported by the National Aeronautics and Space Administration. Headed by Victor J. Johnson, the Center's activities are managed in two principal units—the Data Compilation Unit and the Documentation Unit.

The Data Compilation Unit, under Hans M. Roder, critically evaluates and compiles data on thermodynamic transport, and other thermophysical properties of low temperature fluids—such as electrical resistivity, dielectric constant, thermal conductivity, thermal expansion, specific heat, and enthalpy for certain metallic elements and selected alloys. The Center now has a compendium of 4 volumes of tables covering the thermodynamic and transport properties of the 10 most common cryogenic fluids and a number of solids over the ranges from room temperature to the lowest temperature for which data could be found.

The Documentation Unit, supervised by Neil A. Olien, complements the activities of the Data Compilation Unit. It is responsible for literature acquisition, cataloging, coding, processing, storage and retrieval, for literature searching, and for the distribution and dissemination of literature and data produced by the Compilation Unit. Much of its data processing is mechanized.

The two major services of the Cryogenic Data Center [1] are:

(1) A current awareness service in the form of a list of new literature of cryogenic interest noted by the Center's professional staff. This service is available to the public on a subscription basis at $10 per year ($5 additional if airmailed outside North America).

(2) A custom bibliography service. More than 40,000 accessions of cryogenic literature have been placed in the Data Center's system. Approximately 18,000 of these are on properties of materials (for both fluids and solids) and have been processed for machine searching. Detailed or extensive bibliographies can be prepared with computer facilities. Similarily, about 1,600 patents, 2,000 articles on processes and equipment, and 1,000 articles on instrumentation have also been processed for machine retrieval. Nominal fees are charged for custom searches.

Also available through the Clearinghouse for Federal Scientific and Technical Information are more than 500 documents on cryogenic literature from the Center's files.

Preparation of Text in Machineable Form Needs and Goals

The preparation of text for scientific publications lends itself readily to mechanization, particularly where periodic updating is desired. There are several persuasive reasons for this: mechanization can increase the efficiency of the entire process, can result in a more complete information system package, can increase system effectiveness, can provide timely publications and system response, and can assist in reducing clerical errors.

Efficiency is strikingly demonstrated by the fact that the effort of clerical and professional staff in producing draft copy is reduced by at least a factor of 2 and probably 3 or more, because the mechanized system is able to produce final copy from the original manuscript and changes made in it without the need for a series of manually produced intermediate drafts.

Adequate and proper tagging (marks indicating separation of items) of information in machine-readable form permits a more complete use of the information when the machined records are searched, rearranged, abstracted, and used for the operation of various lists. A good starting place for mechanizing text is in the preparation of bibliographic references. References available in machine-readable form can easily be made to conform with standards of completeness and tagging procedures to

continued

enable the production readily of author, title, journal, and date listings, as well as other indexes in various permutations.

The mechanized system's effectiveness is suggested by the example of machine-produced references. Here the system can provide custom-tailored packages of selected portions of the bibliographic information for uses neither planned nor conceived of by the author. This approach can also be used with properly tagged information in the body of a document, but, in this instance, standard procedures are not easily arrived at. Nonetheless, abstracted data and comments can be assembled with a bibliographic citation by machine to provide files of data in a highly useful form.

Once text is in a machineable form, updated publications, selected data items, or various listings can be obtained rapidly by searching the stored file to provide timely products on a demand or periodic basis.

Currently, the Office of Standard Reference Data is producing the bibliographic and abstract information of publications held by the Office, and it expects to explore the advantages to be gained from a mechanized system. In this effort the Office plans to use its newly developed taxywriter (TNB, July 1966) which produces machined records as input to a mechanized text producing system. The taxywriter was designed to accomplish the following: (*a*) to utilize existing typists with no need for specialized training; (*b*) to produce scientific text in machine readable form where the typed copy indicates the exact correct form and symbols; and (*c*) to produce machine-readable copy with the minimum number of key strokes.

A significant advantage of the mechanized system is that it should produce outputs with a low error incidence resulting from clerical operations, because each successive draft modification or updating would include error corrections for the existing records. Correct records would remain untouched in the clerical procedures designed to eliminate errors.

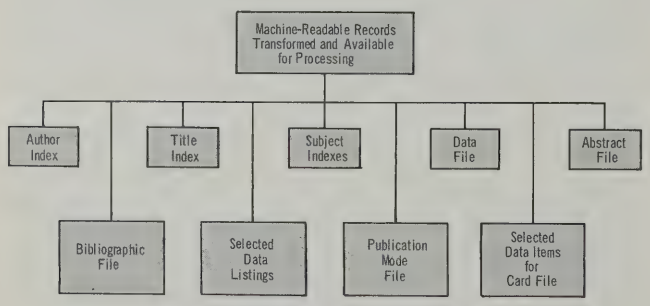


Figure 1 Output Products Made Readily Available from Properly Tagged, Machine-Readable Records.

The Office of Standard Reference Data and its associated data compilation groups expect to gain experience in mechanized text preparation. As each activity works in its own way on its specific problems, the Office of Standard Reference Data will seek to develop compatible modes for use among the different activities. Eventually, when a number of data files and bibliographic listings exist in machineable form, tagged and readily available for use, the transfer of information among compilation centers and such operations as indexing should be accomplished easily.

Information Center on High Temperature Behavior of Inorganic Salts

During the past 20 years, interest in the high-temperature behavior of inorganic compounds has sharply increased. Part of the activity results from the growing need for materials able to withstand the high temperatures employed in modern technology—principally ceramics: oxides, carbides, borides, and nitrides. Another large area of interest centers on the high-temperature behavior of inorganic salts. In the liquid state these form theoretically interesting ionic fluids of high charge density; in addition they are finding increasing application in devices such as fuel cells and atomic reactors, and as reaction media in preparative chemistry and in the electrolytic winning of refractory metals.

Although binary salts generally melt without decomposition and remain stable in the liquid state, many salts with polyatomic anions such as carbonates, sulfates, and nitrates decompose appreciably either below their melting points or in the liquid state.

A major problem for those considering such salts for a particular high temperature application is that there exists at present no source of accurate information on these compounds. At best, one finds unevaluated qualitative statements in the larger reference works of inorganic chemistry.

The NBS Information Center on High Temperature Behavior of Inorganic Salts was therefore initiated and has begun the preparation of a series of monographs on High Temperature Properties and Termal Decomposition of Inorganic Salts. The first of these, on sulfates, was published recently;[2] the second, on carbonates, is in preparation.

This Information Center is investigating three areas for each salt.

I. Reactions—The reactions by which salts decompose in various temperature ranges (intermediate and final products).

II. Thermodynamic Functions—The thermodynamic functions for these reactions: Gibbs energies, free-energy functions, equilibrium constants, and partial pressures.

III. Kinetic Parameters—Kinetic parameters such as rate constants, activation energies, and mechanisms.

Information on reactions is relatively easy to obtain for

carbonates and sulfates, but is expected to be more difficult for nitrogen-oxygen, and halogen-oxygen combinations. To determine the thermodynamic functions of such reactions, the thermodynamic functions for reactants and products over a wide temperature range are required. In a surprisingly large number of cases this information is not available. For example, of the 59 metallic elements forming sulfates, calculations could be carried out only for 11 because some necessary thermodynamic information was missing. Thus the present work also serves to identify areas for experimental research.

Knowledge of the kinetics of thermal decomposition reactions is in the most rudimentary state. None of the information in the literature is of "reference data" quality. Nevertheless, some of this material is included because frequently even qualitative or semiquantitative information is better than nothing. Moreover, a critical examination of the kinetics literature should serve to identify the parameters which significantly affect thermal decomposition, a problem which is not yet solved satisfactorily.

The Information Center on High Temperature Behavior of Inorganic Salts is interested in hearing from actual and potential users of its monographs concerning their usefulness as well as suggestions on materials which they would like to have included.

In addition to the work on thermal decomposition, the Center has an extensive file of molten salt references and will answer inquiries in this field. Comments and queries should be addressed to Dr. Kurt Stern, Director, High Temperature Behavior of Inorganic Salts Information Center, National Bureau of Standards, Washington, D.C. 20234.

European Nuclear Data Activities

Dr. David T. Goldman of the Office of Standard Reference Data visited Europe recently to conduct a seminar at the European Nuclear Energy Program Library at Ispra, Italy, to serve as a U.S. representative to the International Atomic Energy Conference on "Nuclear Data, Microscopic Cross Sections and Other Data Basis for Reactors," and to attend the European-American Nuclear Committee—European-American Advisory Committee on Reactor Physics, Joint Subcommittee on Nuclear Data Evaluation, Paris, France.

The European Nuclear Energy Agency established a center at Ispra, Italy, a few years ago to collect and distribute computer programs useful to nuclear energy activities. The Center acts as a depository for a large variety of computer programs ranging from reactor design through nuclear cross section calculational tools. In addition, the Center checks out all programs that come to it to insure that the version it receives will actually run on the machine called for.

The International Atomic Energy Agency Conference in Paris was attended by approximately 250 participants, including about 25 from the United States. The meeting

View in the Cryogenic Data Center machine room showing the key-punch and paper tape typewriter stations and the file of 25,000 paper tapes of accessions. Standing are Mr. Victor Johnson, Director of the Cryogenic Data Center, and Mrs. Janice Kistner; Mrs. Alberta Ohm is seated at the tape typewriter. All catalog and coding information is now processed on key-punch cards.

was organized to serve as a replacement for the nuclear physics portions of the Geneva Conferences on peaceful uses of atomic energy. It provided an opportunity for experimentalists to report on their latest activities and measurements of nuclear data which are necessary for reactor physics calculations. A large variety of such data was reported, especially on cross sections for fissile and fertile materials. A smaller portion was devoted to the question of the evaluation of cross sections and the determination of the accuracy with which cross sections needed to be known to minimize the uncertainty of the reactor design calculations. Dr. Goldman together with Drs. K. Parker of Aldermaster, England, and L. Wallin of the European Nuclear Energy Agency Data Center, Saclay, France, presented a paper listing all known worldwide neutron cross section evaluation activities in progess or completed.

At the European-American Nuclear Data Committee—European-American Committee on Reactor Physics Joint Subcommittee on Nuclear Data Evaluation, Dr. Goldman reported on the U.S. Atomic Energy Commission's efforts at the establishment of an evaluated nuclear data file by combining the efforts of many different individuals at laboratories around the country. Agreement was reached that such a file would be stored at the ENEA Saclay Data Center for dissemination in Western Europe. The Subcommittee also considered the problem of storing experimental nuclear cross sections on computer tapes for subsequent accession and handling by individual users.

[1] For additional information on services of the Cryogenic Data Center, write Victor Johnson, Director, Cryogenic Data Center, Boulder Laboratories, National Bureau of Standards, Boulder, Colo. 80302.

[2] NSRDS–NBS–7, **High Temperature Properties and Decomposition of Inorganic Salts, Part I. Sulfates,** U.S. Government Printing Office, Washington, D.C. 20402, price 35 cents.

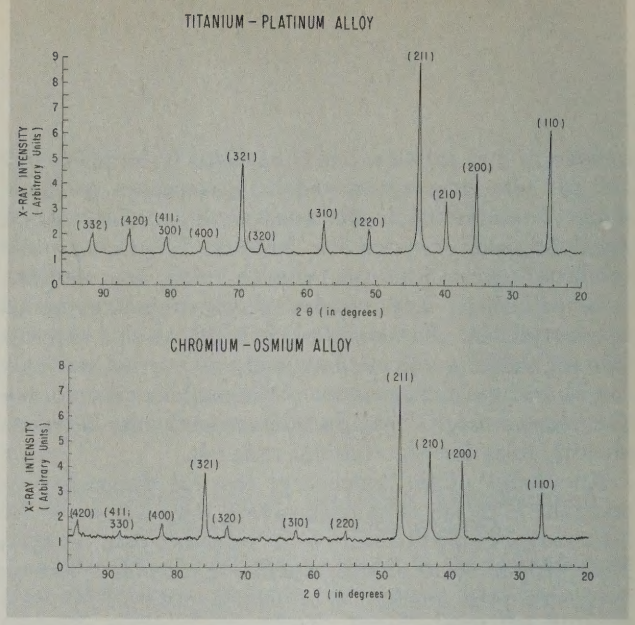
ALLOY STRUCTURE *continued*

for any given lattice site would be changed. The degree of long-range order obtained, however, was much less than could be expected from non-stoichiometry. The causes for this additional disorder in the alloy are now being studied.

The chromium-osmium alloy with the A15 type structure was obtained by a special heat treatment. A 30-gram mixture of special high-purity starting materials (99.999 percent pure chromium and osmium) in the necessary proportions was melted in an electric arc furnace containing an inert argon-helium gas mixture and was then solidified. The resulting solid alloy was heated at 1,400 °C. for 24 hours in a vacuum furnace at NBS [2] while maintaining a vacuum of at least 10^{-6} torr. After this period the alloy was rapidly cooled and then reheated to 800 °C. for 1 hour before slowly cooling to room temperature.

[1] For further technical details see, Non-stoichiometric A15-type phases in the systems Cr-Pt and Cr-Os, by R. M. Waterstrat and E. C. van Reuth, Trans. Met. Soc. AIME (in press). Also, Superconductivity and long-range ordering in A15 structures, by E. C. van Reuth, R. M. Waterstrat, and R. D. Blaugher, presented at an Int. Conf. on Low Temp. Phys., Moscow, U.S.S.R., September 1966.

[2] High-temperature furnace for platinum-group metal studies, NBS Tech. News Bull. 48, 123 (1964).



Examples of x-ray intensity patterns are shown with titanium-platinum, representing a highly ordered structure, and chromium-osmium, a typical alloy with considerable disorder in the structure. The ratios of the line intensities for the (200) and (211) lines are compared and found to be constant for both alloys in agreement with theory. The line intensity ratios for the (110) and (210) lines, however, are extremely sensitive to the degree of long-range order and are therefore quite different. This difference is an indication of the disorder in the chromium-osmium alloy.

PUBLICATIONS *of the National Bureau of Standards**

PERIODICALS

Technical News Bulletin, Volume **51**, No. 1, January 1967. 15 cents. Annual subscription: $1.50. 75 cents additional for foreign mailing. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $5; foreign, $6. Single copy, $1.00.

Section B. Mathematics and Mathematical Physics. Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $2.75; foreign, $3.50. Single copy, 75 cents.

CURRENT ISSUES OF THE JOURNAL OF RESEARCH

J. Res. NBC **71C** (*Engr. and Instr.*), No. 1 (Jan.–Mar. 1967) 75 cents.

Dedication of the new NBS laboratories.

Symmetrical bending of thin circular elastic plates on equally spaced point supports. A. F. Kirstein and R. M. Woolley.

Ultrasonic measurement of cylinder expansion at pressures to 40 kilobars. P. L. M. Heydemann and J. C. Houck.

A comparison of absorbed dose determinations in graphite by cavity ionization measurements and by calorimetry. B. Petree and P. Lamperti.

Germanium resistance thermometry in the range 2.1 to 5.0 °K. M. H. Edlow and H. H. Plumb.

Least squares technique for the analysis of periodic temperatures of the earth's surface region. T. Kusuda.

A new near-zone electric-field-strength meter. F. M. Greene.

Inductance and characteristic impedance of a strip-transmission line. R. L. Brooke, C. A. Hoer, and C. H. Love.

Tensor permeability measurements at L-band frequencies using a degenerate mode cavity. L. B. Schmidt, R. D. Harrington, and W. E. Case.

OTHER NBS PUBLICATIONS

Standard Reference Materials: Viscosity of a standard lead-silica glass, A. Napolitano and E. G. Hawkins, Misc. Publ. 260–11 (Nov. 7, 1966), 25 cents.

Critical Phenomena. Proceedings of a Conference held in Washington, D.C., April 1965, Ed. M. S. Green and J. V. Sengers, Misc. Publ. 273 (Dec. 1, 1966), $2.50.

Thermal conductivity of selected materials, R. W. Powell, C. Y. Ho, and P. E. Liley, NSRDS–NBS 8 (Nov. 25, 1966), $1.00.

Notes on the state-of-the-art of benefit-cost analysis as related to transportation systems, J. D. Crumlish, Tech. Note 294 (Nov. 1, 1966), 30 cents.

Calculation of the heating value of a sample of high purity methane for use as a reference material, G. T. Armstrong, Tech. Note 299 (Dec. 15, 1966), 25 cents.

A standard for accurate phase-angle measurements at audio frequencies, W. W. Scott, Jr., Tech. Note 347 (Oct. 14, 1966), 25 cents.

Fortran programs for the calculation of Wigner 3j, 6j, and 9j coefficients for angular momenta ≤ 80, Tech. Note 409, R. S. Caswell and L. C. Maximon (Nov. 15, 1966), 40 cents.

PUBLICATIONS IN OTHER JOURNALS

This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.

CHEMISTRY

Abstraction of hydrogen atoms from isobutane-d_9 by methylene, M. L. Halberstadt and J. R. McNesby, J. Chem. Phys. **45,** No. 5, 1666–1669 (Sept. 1, 1966).

Chemisorption of nitric oxide on tungsten, J. T. Yates, Jr., and T. E. Madey, J. Chem. Phys. **45,** No. 5, 1623–1634 (Sept. 1, 1966).

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